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USE OF REMOTE SENSING IN AGRICULTURE

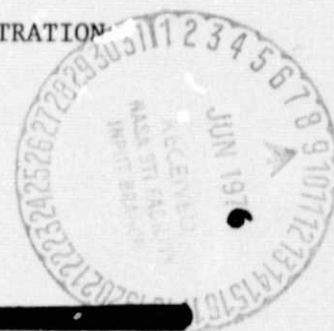
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MAY 1975

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## ABSTRACT

This report describes the work performed for the NASA Wallops Flight Center-Virginia Polytechnic Institute and State University contract entitled "Remote Sensing in Agriculture" during the fourth year of the project. The report deals with the remote sensing studies of (a) cultivated peanut areas in Southeastern Virginia; (b) studies at the Virginia Truck and Ornamentals Research Station near Painter, Virginia, the Eastern Virginia Research Station near Warsaw, Virginia, the Tidewater Research and Continuing Education Center near Suffolk, Virginia, and the Southern Piedmont Research and Continuing Education Center Blackstone, Virginia; (c) land use classification studies Virginia Beach, Virginia.

The practical feasibility of using false color infrared imagery to detect and determine the areal extent of peanut disease infestation of Cylindrocladium black rot and Sclerotinia blight has been clearly demonstrated. These diseases pose a severe hazard to this major agricultural food commodity. The value of remote sensing technology in terrain analyses and land use classification of diverse land areas has also been investigated. Continued refinement of "spectral signatures" of major agronomic crops and documentation of pertinent environmental variables have provided a data base for the generation of an agricultural-environmental prediction model.

## INTRODUCTION

Major emphasis has been directed towards the practical utilization of remote sensing in agriculture. Using the data base and knowledge gained in the previous three years of the project, studies were directed towards the detection of Cylindrocladium black rot and Sclerotinia blight of peanuts via remote sensing technology. These studies have been initiated at controlled experimental plots and typical commercial agricultural operations while working closely with researchers, extension agents, and farmers. The integration of remote sensing technology with agronomic practices has been introduced to a large segment of extensive agricultural production areas of Virginia.

Demonstrations of the utilitarian nature of remote sensing in gathering diverse data of large land areas with minimum ground truth have been accomplished. Preparation of usable maps and plans of such areas from the imagery has involved agricultural and urban commodity groups.

USE OF REMOTE SENSING TO DETECT CYLINDROCLADIUM  
BLACK ROT DISEASE OF PEANUTS

Introduction

In the United States the Cylindrocaldium black rot disease of peanuts (CBR) was first recognized as a problem in Georgia in 1965, and later was found in South Carolina in 1968 (Garren et. al. 1972). In Virginia, CBR was first discovered in one peanut field in 1970 (Garren et. al. 1971). In 1971 CBR was found in two fields in Virginia and several fields in the Williamston, N. C. area (Garren, et. al. 1972). Garren (1973) reported that without a concerted survey CBR was found to be severe in 10 fields in four counties in Virginia in 1972 while North Carolina reported 40 infestations of CBR during the 1972 growing season (Rowe et al. 1973). In Virginia, for 1973, there were between 20-25 fields of CBR reported in the three county/city regions of Isle of Wight and Southampton Counties and the City of Suffolk (private communication - Kenneth H. Garren).

The disease symptoms are described by Garren and Jackson (1973). The first symptoms of diseased plants in the field are chlorosis and wilting of the leaves on the main axis, followed by chlorosis and wilting of the remaining foliage and blighting of the leaf tips and margins. The main axis often is more extensively affected than the lateral branches. Hypocotyls and tap roots are necrotic and blackened, with necrosis usually terminating near the groundline. Frequently, the entire root system of a diseased plant is destroyed leaving a blackened and fragmented hypocotyl. Adventitious roots often develop on diseased plants near the groundline. Dark, slightly sunken lesions occur on pegs and pods. Lesions on pods are usually discrete, but occasionally the entire pod is affected. Reddish-orange perithecia of

the sexual stage, Calonectria crotalariae (Loos) Bell and Sobers, are occasionally visible just above the ground on moribund stems. These structures are a positive sign of the pathogen that may be seen in the field. Testa of infected seeds exhibit faint and profuse stippling with minute tan specks.

Control practices for CBR are almost non-existent. At the present time no chemical or commercial peanut variety provides adequate control. Early detection and diagnosis of the disease is important. Infested areas of the disease need to be detected and isolated through proper management practices to minimize the spread of the fungus.

CBR is of major economic importance to the peanut growers of Virginia and North Carolina. This fungus also affects soybeans and tobacco and, therefore, could be a major economic threat to Virginia and North Carolina agriculture.

Because of the serious threat posed by CBR, it was decided to undertake a preliminary study during the 1973 and 1974 growing seasons to determine if natural color and false color infrared imagery could be used to detect and record the occurrence and spread of the disease.

#### Methods and Materials

On September 18, 1973, natural color and color infrared photographs (for imagery) were taken of CBR plots on the W. C. Knight farm at Cypress Chapel in the City of Suffolk. On the same day, photographs were also taken of the peanut field on the Bernard Knight farm near the Virginia/North Carolina border in the City of Suffolk (Table I).

During the 1974 growing season imagery (natural color and color infrared) was obtained of the CBR plots on the W. C. Knight and Bernard Knight farms in the City of Suffolk and the Butler farm in Isle of Wight County (Table I). These CBR research plots were established by USDA-ARS personnel at the Tidewater Research and Continuing Education Center in cooperation with the Plant Pathology and Physiology Department at VPI & SU. Ground truth information was collected for each flight and included soil moisture samples, type of ground cover, percent ground cover, and evidence of disease. During the growing season, U. S. Department of Agriculture-Agricultural Research Service personnel from the Tidewater Research and Continuing Education Center collected ground truth on the extent of CBR damage in the plots.

Also during the 1974 growing season two flights were conducted over portions of Isle of Wight and Southampton Counties and the City of Suffolk. One flight was conducted over this two county and one city area utilizing the C-54 aircraft at 3,504 m and collecting false color infrared imagery. The other flight was conducted over this region plus the eastern portions of Sussex and Surry Counties. The aircraft used was a U-2 taking false color infrared pictures from 19,803 m. Ground truth information included determining fields where known infestations of CBR had occurred during the 1974 growing season. This information was provided by the county/city Agriculture Extension Directors.

#### Results and Discussion

From the September 18, 1973, data it was evident that CBR could be readily detected after the disease had developed. The 1973 flight provided a good reference with which future flights over CBR areas could be compared.

Also, future CBR research plots could be located in areas of high infestations by use of this 1973 imagery. It was evident from the 1973 imagery that false color infrared imagery was much better for CBR monitoring than natural color imagery.

As noted in Table I, there were only two flights conducted over the CBR plots located on the Butler Farm in Isle of Wight County. At the time the third flight was conducted (October 3, 1974) the peanuts had been harvested from these plots. There were three flights conducted over the W. C. Knight and Bernard Knight farms in the City of Suffolk. This imagery is being evaluated to determine if natural color and false color infrared photography can be used for pre-visual detection of CBR. This information will be determined by machine processing of the data at Wallops Flight Center.

The C-54 flight conducted at 12,500 feet over parts of Southampton and Isle of Wight Counties and the City of Suffolk provided high quality false color infrared imagery of the area. There was incomplete ground coverage where the parallel flight lines did not overlap. This occurred over about 5-10 percent of the study area. Three to five fields reported to have CBR in the area were not photographed because of this missing coverage.

From the September 18, 1974, flight, it was determined that CBR could be easily detected in the fields where as little as five percent of the field was infested. One problem encountered with this flight was that of visually distinguishing between soybean and peanut fields. During the growing season, the canopies of peanuts and soybeans were very similar. The plants were uniformly green and covered 100 percent of the ground area. The fields, therefore, appeared as uniform red fields on the false color infrared photographs.

To verify which fields were peanuts and which were soybeans (or cotton in three cases) two methods were used: (1) go into the field and make visual checks and (2) go to the county/city Agricultural Stabilization and Conservation Service (ASCS) offices and check their records. Since peanuts were under the USDA allotment program, the ASCS offices had records showing where 90 percent of the peanut fields were grown. Peanut fields were depicted on aerial photographs at the ASCS offices.

The U-2 flight conducted over parts of the four county/one city area provided high quality false color infrared imagery of the area. One hundred percent of the ground in the area was photographed. From this flight on September 10, 1974, CBR fields with areas of severe CBR infestation could easily be detected. The same problem of distinguishing between peanuts and soybeans was present as it was with the September 18, 1974, C-54 flight.

Since the imagery from the above two flights was not available to the principal investigators for viewing until after the peanuts were harvested, the problem of determining if a field that appeared to be CBR infested was actually infested had to be solved. To positively identify fields as being CBR disease infested, soil samples are being collected and assayed in the laboratory with a Cylindrocladium specific procedure. If the organism can be cultured, then it is assumed that the field contained CBR during 1974. If the organism cannot be cultured, then it is assumed that the abnormal appearance of the field on the imagery was due to something other than CBR disease. The medium and procedure used for assaying the Cylindrocladium organism is one developed by Dr. Gary J. Griffin of the Plant Pathology and Physiology Department at VPI & SU. This lab study is being carried out jointly

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between the Departments of Agronomy and Plant Pathology-Physiology at VPI & SU, and the USDA-ARS researchers from the Tidewater Research and Continuing Education Center. Partial support for the assay method is being provided by the Peanut Growers Association of Virginia.

At the present time, ten samples have been processed under the above study; seven have proved to be positive (the fields contained CBR) and three have given negative results.

A preliminary study of the imagery from the C-54 and U-2 flights indicates there are approximately 160 fields to be considered. Of these, 51 have been reported by the county/city extension directors as being CBR infested. Three of the 51 fields were not photographed. The U-2 flight photographed 35 fields and the C-54 flight photographed 37 fields of known CBR infestations. There are 71 additional fields suspected of being infested with CBR and approximately 35 fields which have not been identified as peanuts or soybeans. If these fields are peanuts, then they will be suspected of CBR infestation.

#### Summary

From this preliminary study, we have found that false color infrared imagery can be utilized to detect CBR infestations in peanut fields. The study is incomplete. Work remaining to be done with the 1973 and 1974 data includes:

1. Evaluating the imagery over the three plot areas to determine if pre-visual detection of CBR is feasible utilizing natural color and false color infrared imagery. This will be done by using the remote sensing machine processing equipment at Wallops Flight Center and the LARSYS terminal of Purdue University.

2. Evaluate the U-2 and C-54 imagery for known CBR infested fields to see if there was much change in the degree of infestation with time and the degree of spreading.
3. Determine the spectral signature for CBR infestation and determine how this compares with other diseases such as Sclerotinia blight.
4. Collect additional ground information to determine if this disease can be related to chemical, physical and/or mineralogical properties of the soil.

TABLE I. FLIGHTS CONDUCTED FOR CYLINDROCLADIUM BLACK ROT DISEASE  
OF PEANUT STUDIES

<u>Date</u>	<u>Imagery</u>	<u>Camera</u>	<u>Lens Focal Length (mm)</u>	<u>Altitude (m)</u>	<u>Remarks</u>
July 10, 1974	Natural Color Color IR	T-11	152	152 & 305	W. C. Knight, B. Knight & Butler CBR plots
Sept. 9, 1974	Natural Color Color IR	T-11	152	152 & 305	W. C. Knight, B. Knight & Butler CBR plots
Sept. 10, 1974	Color IR	RC-10	305	15,803	City of Suffolk, Southampton, Isle of Wight, Sussex, and Surry counties
Sept. 18, 1974	Color IR	T-11	152	3,504	City of Suffolk, Southampton and Isle of Wight counties
Oct. 3, 1974	Natural Color	T-11	152	305 & 610	W. C. Knight and B. Knight CBR plots

## USE OF REMOTE SENSING TO DETECT

SCLEROTINIA BLIGHT OF PEANUTS

Symptoms of a disease closely resembling severe Botrytis blight were observed by Porter and Buete (1974) on field-grown peanuts in Virginia in 1971. This disease was observed during the 1972 growing season in both Virginia and North Carolina, ranging from less than one percent in some fields to greater than fifty percent in others. Severity of the disease ranged from death of the plant to single - or multi-branch infections. The causal fungus, isolated from blighted peanuts, has been identified as Sclerotinia sclerotiorum. Sclerotinia blight (SB) of peanuts has been reported earlier in China, Japan, and Argentina. This was thought to be the first report of Sclerotinia blight of peanuts in the United States (Porter and Beute, 1974).

Because of the recent recognition of the disease, there are no known economical chemical or genetic controls for this disease. This disease could pose a severe economic threat to the peanut growing industry of the states of North Carolina and Virginia. It was for this reason that a preliminary study was undertaken during the 1974 growing season to determine if natural color and false color infrared imagery could be used to detect and record the occurrence and spread of the disease.

## Methods and Materials

During the 1974 growing season natural color and color infrared imagery was obtained of two Sclerotinia blight research plots in Southampton County, Virginia, near the town of Franklin (Table II). These research plots were established by USDA/ARS personnel at the Tidewater Research and Continuing

REPRODUCIBILITY OF THE  
ORIGINAL PAGE IS POOR

Education Center at Holland, Virginia. Ground truth information concerning variety of peanuts planted, dates planted, chemical treatments, etc. is on file with the personnel in charge of the plots. Information collected during the flight included soil moisture samples, type of ground cover, percent of ground cover, and evidence of disease.

Also during the 1974 growing season, two flights were conducted over portions of Southampton, Isle of Wight, Surry, and Sussex Counties, and the City of Suffolk. One flight was conducted September 10, 1974, from 19,803 m collecting false color infrared imagery of the area. The other flight conducted September 18, 1974, from 3,504 m also collected false color infrared imagery (Table II). The ground truth information will consist of determining from the Southampton County Extension Agent fields which were affected by Sclerotinia blight and locating this on the imagery.

#### Results and Discussion

Classic symptoms of Sclerotinia blight developed to a high degree on only one set of research plots over which the low altitude flights were flown. From the imagery obtained of these plots it is readily apparent that the disease can be detected easily by natural color and false color infrared imagery after it has developed. For this particular season the disease symptoms were particularly visible on the October 3, 1974, flight.

The imagery of the research plots will be used to determine if pre-visual detection of Sclerotinia blight is a possibility with natural color and color infrared photography. This information will be determined by machine processing of the data at Wallops Flight Center.

Work remaining to be completed in evaluating the imagery includes:

1. Evaluating the imagery for the research plots to determine if pre-visual detection of the Sclerotinia blight is a possibility utilizing natural color and false color infrared imagery.
2. Evaluating the imagery of the two high altitude flights for known infested fields to see if there is much change in the degree of infestation with time.
3. Determine the spectral signature of Sclerotinia blight and determine how this compares with other diseases of peanuts such as CBR.
4. Collect additional ground information to determine if this disease can be related to chemical, physical and/or mineralogical properties of the soil.

TABLE II. FLIGHTS CONDUCTED FOR SCLEROTINIA BLIGHT OF PEANUTS STUDIES

<u>Date</u>	<u>Imagery</u>	<u>Camera</u>	<u>Lens Focal Length (mm)</u>	<u>Altitude (m)</u>	<u>Remarks</u>
July 10, 1974	Natural Color Color Infrared	T-11	152	152 & 305	Two sets of research plots in Southampton County, Virginia
Sept. 9, 1974	Natural Color Color Infrared	T-11	152	152 & 305	Two sets of research plots in Southampton County, Virginia
Sept. 10, 1974	Color Infrared	RC-10	305	19,803	City of Suffolk, Southampton Isle of Wight, Sussex and Surry Counties
Sept. 18, 1974	Color Infrared	T-11	152	3,504	City of Suffolk, Southampton, and Isle of Wight counties
Oct. 3, 1974	Color Infrared	T-11	152	305 & 610	Two sets of research plots in Southampton County, Virginia

## REMOTE SENSING FLIGHTS OF THE AGRICULTURAL EXPERIMENT STATIONS

During the 1974 growing season three flights were conducted over the Virginia Truck and Ornamentals Research Station, Painter, and the Eastern Virginia Research Station, Warsaw. Four flights were conducted over the Tidewater Research and Continuing Education Center, Suffolk, Virginia. A summary of these flights is given in Table III.

Information gained from these flights is being incorporated with existing research programs in progress at the stations. At the present time there are several investigators at the stations who are interested in utilizing the imagery in the evaluation of their research data. In addition, the information is being used to develop spectral signatures for the dominant crops being grown in the regions.

At the present time, Mr. Mark Alley is completing his Ph.D. dissertation entitled "Manganese in Virginia Soils and Correction of Manganese Deficiency in Soybeans (Glycine max L.)". One set of his research plots was located at the Tidewater Research and Continuing Education Center and photographed four times during the growing season. Information from these flights will be included in his dissertation. Also during the growing season, Dr. John C. Smith had research plots at the Tidewater Station to investigate the effects of certain chemicals on preventing Mexican Bean Beetle damage to soybeans. In the same general area, Mr. M. W. Alexander had research plots for evaluating different varieties of soybeans. Using information available from these three research studies, together with other ground truth and the imagery from four flights, it should be possible to develop spectral signatures for the factors involved in soybean production. Also, we should be able to determine the usefulness of remote sensing imagery in evaluating agricultural research studies.

There are several studies similar to the above that were in progress during the 1974 growing season at the Eastern Virginia Research Station and the Virginia Truck and Ornamentals Research Station that will be used in our studies on the use of remote sensing by agriculture.

Specific work to be completed on the 1974 flights include

1. Evaluation of the manganese and Mexican Bean Beetle studies of soybean by remote sensing.
2. Evaluation of the use of remote sensing in soybean variety trial studies at the three research stations.
3. Evaluation of the use of remote sensing in soybean disease studies at the Eastern Virginia Research Station, Warsaw (in cooperation with Dr. C. W. Roane of VPI & SU).

TABLE III. FLIGHTS CONDUCTED OVER THE VIRGINIA TRUCK AND ORNAMENTALS RESEARCH STATION, THE EASTERN VIRGINIA RESEARCH STATION AND THE TIDEWATER RESEARCH AND CONTINUING EDUCATION CENTER.

<u>Date</u>	<u>Imagery</u>	<u>Camera</u>	<u>Lens Focal Length (mm)</u>	<u>Altitude (m)</u>	<u>Remarks</u>
June 10, 1974	Natural Color Color IR	T-11	152	305 & 610	All three stations
July 29, 1974	Natural Color Color IR	T-11	152	305 & 610	All three stations
Sept. 9, 1974	Natural Color Color IR	T-11	152	305 & 610	All three stations
Oct. 3, 1974	Natural Color Color IR	T-11	152	305 & 610	Tidewater Research & CEC

## TERRAIN ANALYSES OF THE SOUTHERN PIEDMONT RESEARCH AND CONTINUING EDUCATION CENTER VIA REMOTE SENSING TECHNIQUES

The Southern Piedmont Research and Continuing Education Center is located at Camp Pickett, approximately one mile east of Blackstone, Virginia, in southeastern Nottoway County. The Center comprises approximately 1130 acres situated in the gently sloping topography of the southern Piedmont. The developing multi-purpose agricultural research station will integrate agricultural research and development for the extensive southern Piedmont region.

This study was designed (a) to photographically document the development of native wooded tract of land into a multi-purpose research station; (b) to classify, via remote sensing techniques, the various land-use classes and cultural alterations; (c) to define the topographical-drainage conditions and depict them on a base map showing cultural features.

### Methods and Materials

A remote sensing overflight of the research station was conducted on December 11, 1972. The NASA-Wallops Flight Center C-54 aircraft was utilized as an aerial platform at altitudes of 762 and 1,523 m to obtain color (SO-397) and color-infrared (2443) imagery. The overflight was made at approximately noon under very cloudy overcast conditions. During the photographic passes, the sun intermittently broke through the overcast contributing to variations in the imagery. The flight date was selected for a

period when the trees had lost their leaves in order to penetrate the forest canopy and enhance soil conditions.

The imagery utilized were composed of 22.86 X 22.86 cm color (S0-397) and color-infrared (2443) photographic prints and positive transparencies. The equipment used in the photo-interpretation included small folding stereoscopes, a Delft scanning stereoscope, and a Richards light table (Model GFL-918X).

After initial examination of the imagery, it was concluded that the natural color photographs (S0-397) provided better contrast for the purpose of this study. However, the infrared imagery (IR-2443) was consulted in making delineations, especially in locating the courses of minor streams under forest vegetation.

The photo interpretation was done manually. To prepare the photographs for viewing, principal points (PP) and conjugate principal points (CPP) were located and circumscribed, the former using fiducial marks. Flightlines were then located and marked via constructed lines. Next, wing points were located, circumscribed, and short radial lines subtended from them. The wing points were stereoscopically transferred between all adjacent frames in all the 38 frames covering the study area.

All the photographs were closely examined via Delft scanning stereoscope to gain familiarity with the terrain features of the area before any delineations were made. Then each adjacent pair of photographs was stereoscopically delineated into the various categories shown in Table IV.

TABLE IV. CLASSIFICATION OF MAP DELINEATION CATEGORIES OF THE SOUTHERN PIEDMONT STATION

---

Cd	Culturally distrubed, timber previously harvested and replanted.
D	Disturbed areas, due to repeated movement of heavy military equipment resulting in partial or nearly complete destruction of vegetative cover and some compaction of the soil.
E	Eroded, less than 15 cm of the subsoil removed.
G	Severely eroded and gullied, more than 15 cm of the subsoil removed.
L	Homestead lawn.
C	Cultivated
R-O-W	Right of Ways
=	Roads
~ ... ~	Streams
~ ~ ~	Water Divides

---

In cases where the contrast was clear-cut, for example, between the highway and adjacent right-of-way, or between right-of-way and a forest, the delineation lines were not drawn on the photographs.

The study area was visited and the delineations checked both on foot and via overland vehicle. Most of the features were thus field-checked and verified with the assistance of the Research Center Staff.

For the construction of a radial line plot, alternate frames in most cases were chosen. In doing this, an attempt was made to include frames which had most of the major features of interest contoured within them. A tracing paper (22.86 X 22.86 cm) copy was prepared for each of the chosen prints. A radial line plot was made for each of the frames by transferring the principal points (PP), conjugate principal points (CPP), wing points (WP), flight lines, and radial lines. PP's, CPP's and Wing Points were all circumscribed. Each photo frame was then taped on the light table and a tracing

paper placed over it. Thus, all the delineations, including all those previously showing clear contrasts, were traced.

Lastly, all the individual radial line plots were made into a mosaic and taped onto a light table. One large tracing paper was then placed on the mosaic and all delineations transferred to one single map of the study area. Map scale was determined by comparing distances in various directions between points of established distances. Quantitative measurements of individual classification units were accomplished via planimeter and acreage grid overlays.

### Results and Discussion

The map prepared from the imagery with an approximate scale of 1 inch = 117  $\pm$  3 m is shown in Figure 1. The Research Station is bounded on the north by U. S. Route 460 and on the south by Virginia Route 40. The site is bisected by Military Highway and the Norfolk and Western Railroad in a north-south direction. The outer boundary of the site is irregular. Most of the disturbed area is located in the southern portion of the site. A thin strip of gullied land occurs in a north-south fashion along the eastern boundary. The site appears to have five major watershed areas.

The classification categories and percentage composition for each category are shown in Table V.

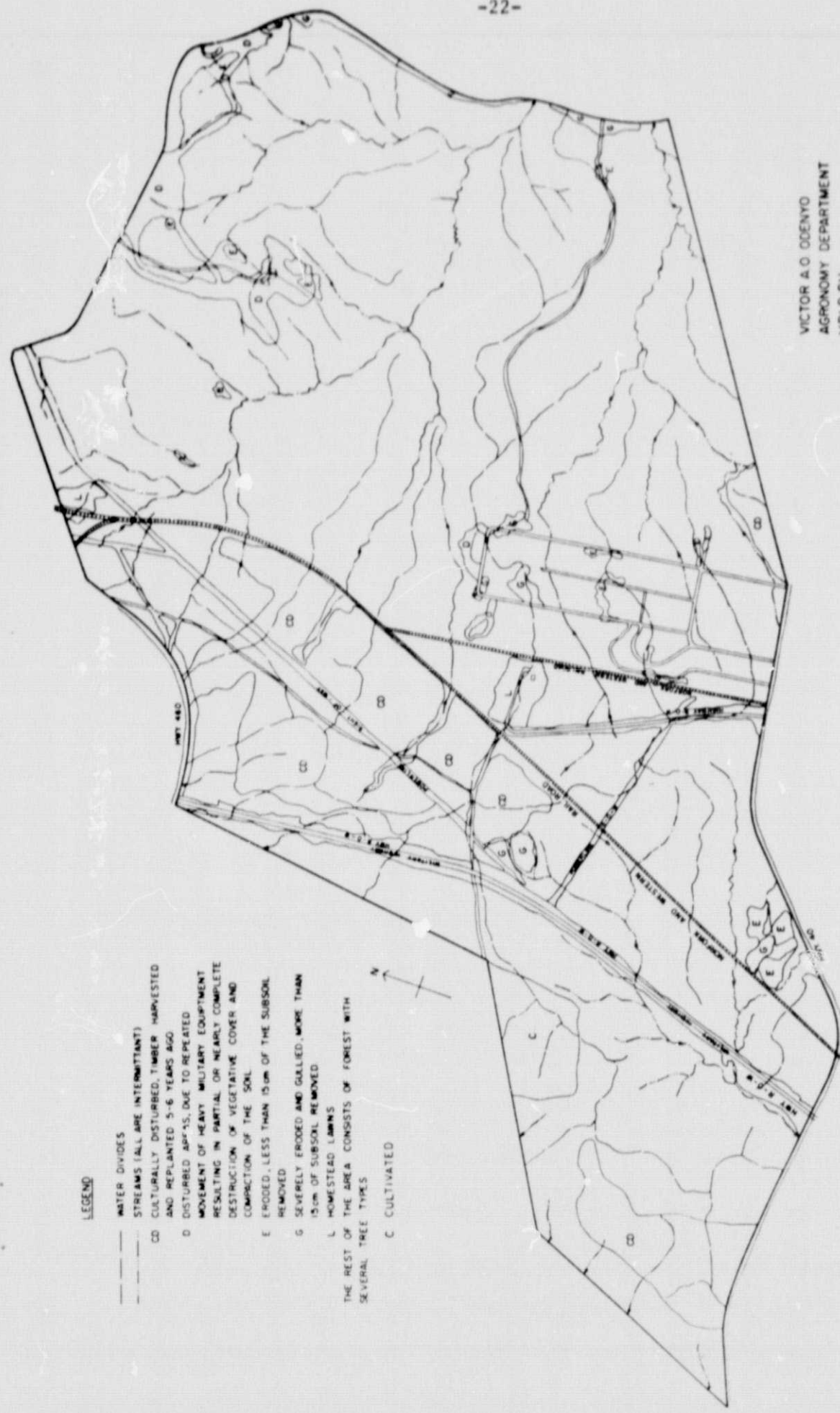
TABLE V. CLASSIFICATION CATEGORIES AND PERCENTAGE COMPOSITION OF UNITS SEPARATED VIA REMOTE SENSING TECHNIQUES

Category	No. Acres	Percentage of Total
C (cultivated)	15.9	1.4
Cd (culturally disturbed)	115.6	10.2
D (disturbed)	26.0	2.3
G (gullied)	11.3	1.0
E (eroded)	7.9	0.7
L (lawns)	5.7	0.5
Roads	22.7	2.0
R-O-W (Right of Ways)	31.7	2.8
Forest*	896.2	79.1
Total	1133	100

\*included acreage other than disturbed areas and consists of various species.

As shown in Table V, almost 80 percent of the site remains in forest with about 10 percent of the area recently cleared. Roads and right-of-ways comprise less than five percent of the total area. Less than two percent of the site is comprised of eroded and gullied land. The ratio of land with minor alteration to that with major constraints is about 9 to 1. The roads and railroad pass through about three major watershed areas.

The map and terrain analyses of the research station attests to the feasibility and practical usage of remote sensing technology in natural resource land use inventories. Despite imagery of a marginal nature obtained from a single overflight, the usefulness of such technology is evident. Additionally, from a temporal viewpoint, progressive image documentation with development of the facility will provide an invaluable visual data base with objective documentation.



LEGEND

- WATER DIVIDES
- STREAMS (ALL ARE INTERMITTENT)
- CD CULTURALLY DISTURBED, TIMBER HARVESTED AND REPLANTED 5-6 YEARS AGO
- D DISTURBED APR 15, DUE TO REPEATED MOVEMENT OF HEAVY MILITARY EQUIPMENT RESULTING IN PARTIAL OR NEARLY COMPLETE DESTRUCTION OF VEGETATIVE COVER AND COMPACTION OF THE SOIL
- E ERODED, LESS THAN 15 CM OF THE SUBSOIL REMOVED
- G SEVERELY ERODED AND GULLED MORE THAN 15 CM OF SUBSOIL REMOVED
- L HOMESTEAD LANDS
- THE REST OF THE AREA CONSISTS OF FOREST WITH SEVERAL TREE TYPES
- C CULTIVATED

VICTOR A O ODENYO  
AGRONOMY DEPARTMENT  
VPI & SU  
NASA - WOLLOPS ISLAND

Fig. 1 - SOUTHERN PIEDMONT RESEARCH AND CONTINUING EDUCATION CENTER  
TERRAIN ANALYSIS NOVEMBER 1972

## LAND USE CLASSIFICATION PROJECT, VIRGINIA BEACH

Land classification, whether via the terrain-type approach or the physiographic subdivision approach (Heath, 1956), is designed to facilitate systematic description of land units for a clear topographic (geomorphological) understanding and interpretation. Land can also be classified for the benefit of land use planners (Klingebiel, 1963).

By definition, land use classification schemes classify the land according to its use; that is, according to the dominant activity prevalent on it (at the time of final observation or of photography). Some researchers would like to restrict the meaning of the term land use to "... the end to which land is allocated, assuming a conscious decision to use it for a desired end" (Clawson, 1960). Others prefer to restrict it to mean man's activities on land which are directly related to the land. In practice, however, it tends to encompass both.

In an area such as the City of Virginia Beach, where living 7.6 m above sea level is tantamount to looking down upon the rest of the City, Clawson's definition (1960) seems to deserve more consideration; yet, the second perspective cannot be ignored. The change in land use in this area, mainly from agricultural to urban-suburban, is taking place very rapidly. This was underscored by the participants in a conference on the Remote Sensing of the Chesapeake Bay held in April, 1971, who noted that "urban development and growth on the shoreline of the bay, along its tributaries, and in the headwaters of the bay present some special problems with respect to the bay." It was recognized that "development rates and trends, and land use should be studied for the purpose of policy-making and planning at the federal, regional,

state, and local levels." Several problem areas were recognized, two of which were characterized as "very important problems." These were: (1) the rapidity of land use and functional change, coupled with delays in obtaining pertinent data promptly by means of traditional techniques, and (2) differences in definition and categorization of urban land uses from place to place, coupled with differences among studies in time, scale, and purpose. Consequently, one of the recommendations adopted was to "urge NASA Wallops to prepare a list of studies within the Chesapeake Bay area by national, state, regional, and local agencies revealed by participants at the conference."

Through the Central Atlantic Regional Ecological Test Site (CARETS) project, the U. S. Geological Survey (USGS) has conducted various studies that have included the Chesapeake Bay area. Alexander (1973b) has reported on a regional-scale overview that has attempted to link land use and environmental process in the CARETS area. Dolan and Vincent (1972) have reported an attempt to evaluate land use (and land cover) mapping from ERTS for barrier islands of the mid-Atlantic coast. Alexander (1973a) has attempted to classify land use and to analyze changes in land use in a South Norfolk test site of the CARETS region. These studies have used manual procedures. Further, Alexander (1973a) did not vary the study to the stage of examining the operational applicability of the techniques used in the experiments nor to relating the identified changes in land use to the soil conditions of the relevant areas.

Essentially, previous studies have classified the land use according to the USGS Land Use Classification (Circular 671, 1972). This consists of

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a two level land use classification system utilizing remote sensing data. Level I is for use with spacecraft data with very little supplemental information, and Level II is designed for use with high altitude aircraft data. Thus, they have employed the deductive approach (Nunnally and Witmer, 1970) to land use classification. However, in order to realize the maximum potential of the ERTS imagery, the classification need not be confined to predetermined land use classes. This calls for the inductive approach.

Therefore, this study was initiated with the following objectives:

Generally, to evaluate land use classification maps obtainable from satellite (ERTS) data and high altitude imagery with reference to their accuracy and usability, and specifically,

1. to determine what level of land use information is obtainable from each kind of data source,
2. to derive relevant training classes applicable in the area under study using those hitherto used, and
3. to investigate the feasibility of determining and quantifying land use changes with these instruments and techniques.

In addition, attempts will be made to relate the land use and changes in land use to the soils of the area. Finally, it is hoped that the approach and technique developed can be applicable on an operational basis by land use planners and administrators.

#### Methodology

Photographic imagery (U-2) and other conventional aerial photography, and ERTS-1 digital data are being used. The hardware available for this study

located mainly at the NASA Wallops Flight Center included, among others, table stereoscopes, a microdensitometer, an I<sup>1</sup>S mini-addcol viewer, and the center's computer. Also, the LARSYS Pattern Recognition Software of LARS, Purdue University is being utilized via the computer terminal at the NASA Wallops Flight Center. It is planned, if possible, also to utilize advanced equipment (Image 100) currently available at the NASA Goddard Space Flight Center.

Ground truth data are being collected mainly by examining maps (especially USGS-7-1/2 min. quadrangles) and by personal inspection. Imagery that lends itself to manual examination is also being used in this respect.

#### Present Status

Work on the project was begun in August 1974, with a 13-day visit at the NASA Wallops Flight Center and the City of Virginia Beach. A second eight-day visit was made during December.

Many of the ground features have now been identified. All available imagery (as of December 22, 1974, and held at the data center of the Chesapeake Bay Ecological Program) have been manually examined in slides, positive transparency rolls, prints, and negatives with the aid of light tables, the color combiner, etc. These included more than five C-54 flights, four U-2 flights, and more than nine ERTS-1 passes. Consequently, the U-2 flight No. 73-185 of November 1, 1973, frames 5575, 5576, 5577, and 5578, and the ERTS pass of August 30, 1973, have been selected for detailed analysis.

Density slicing has been done on the ERTS data and at the present time selection of candidate training classes and test samples is in progress.

Two east-west strips, one in the north and another in the south, of the U-2 imagery, have been digitized and reformatted for LARSYS (Run 73212200 and Run 73212300). Density slicing has been done on these; and they are now being examined before a decision is made on what filters to use to digitize the entire area.

Work on this project will continue in 1975.

## SUMMARY

The practical usefulness of remote sensing technology in agronomic production of major economic crops has been demonstrated. The potential economic gains resulting from such integration of this technology with the agricultural sectors remain to be established. They appear to be very substantial and extensive utilization of such cooperative operations could enhance production of food and fibre.

The valuable data bases obtained on major agricultural crops and environmental data provide the foundation for the inauguration of a practical agricultural-environmental yield model. Future emphases will be directed towards further amplification of feasible utilization of remote sensing technology in the production of food and fibre, and land use.

## Publications and Papers Presented at Conferences

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Bliley, D. J. and D. E. Pettry. 1974. Soils and Morphology of Carolina Bays on the Eastern Shore of Virginia. American Society of Agronomy Abstracts, Chicago, Illinois.

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